

EFFECT OF AN EXERCISE BASED INTERVENTION ON VIRTUAL TIME TO
CONTACT AND SEATED INSTABILITY INDEX AS A FUNCTION OF SEATED
POSTURAL CONTROL

BY
ZADOK ISAACS

THESIS

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Advisers:

Assistant Professor Laura Rice
Associate Professor Jacob J. Sosnoff

Abstract

Seated postural control is an essential component of daily life for non-ambulatory persons with Multiple Sclerosis (PwMS). Multiple sclerosis has negative effects on the central and peripheral control processes, however there is a lack of validated rehabilitary strategies to improve seated postural control in PwMS. Therefore, purpose of this study is to investigate the effectiveness of an exercise-based intervention as a rehabilitary treatment for non-ambulatory PwMS. An experimental treatment program was designed utilizing core exercise. The program lasted 3 months, with assessments taking place pre and post exercise intervention. Seventeen participants took part in the investigation. Static and dynamic seated postural control was assessed using force platform metrics. Virtual Time to Contact (VTC) and Seated Instability Index (SII) were calculated. There were no differences in mean VTC or SII between groups. Additional testing revealed significant percent change from zero was found in VTC ($p=0.007$) as a result of the intervention. This shows that the intervention may be a valid means of improving seated postural control. More research needs to be done to further these findings.

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Chapter 1

Introduction

Multiple Sclerosis (MS) is a chronic, debilitating, neurologic disease that impacts mainly adults [1]. It exists worldwide, with higher prevalence corresponding with certain geographic locations such as Central and Northern Europe and North America [1, 2]. Research has shown that 400,000 persons in the US have MS, 2.1 million worldwide [3]. The disease itself involves intermittent bursts of focal inflammation within the central nervous system (CNS). Ultimately, this inflammation results in the destruction of portions of the axons and neural degeneration [1]. Muscle weakness, sensory disturbances, cognitive impairment, gait ataxia and clumsiness are symptoms that result from this neural degeneration with the symptoms worsening under increased body temperatures. These symptoms contribute to the development of functional impairments such as impaired gait and postural control [1, 4].

Given these symptoms, it is not surprising that individuals living with MS are at a high risk for falls [5, 6]. In a six-month period, 50% of persons with MS report falling [6, 7]. Multiple studies have reported consistent findings of these fall rates and others follow up showing that 23% of falls required medical care [4]. Some of the risk factors associated with falls such as decreased gait and balance and muscle weakness [8] are also symptoms of MS. Given that persons with Multiple Sclerosis (PwMS) have lower bone mineral density compared to healthy controls, they are at higher risk of developing more serious injuries, including fractures, concussions, dislocations and amputations [6, 9-11]. Despite all this, PwMS have a limited understanding of the causes and risks of falls, especially in the non-ambulatory population [4, 12].

A quarter of the MS population is considered non-ambulatory, meaning they use a wheeled mobility device as their primary means of mobility both in their homes and the community [8]. A systematic review by Rice et al. has shown that there is a distinct lack of research in the areas of fall risk management and seated postural control in many groups of non-ambulatory adults including those with Multiple Sclerosis [7]. Between 30% and 60% of all non-ambulatory persons are impacted by falls and the number of falls a person experiences increases with age [13, 14]. There are close to 100,000 wheelchair accidents yearly, many of which result in falls and require medical attention [15]. Fall-related injuries are responsible for 68% of all fatal wheelchair related accidents, making fall risk management in non-ambulatory persons a very important focus for research [16].

Impaired postural control is related to falls [17]. Due to the neurological degradation of the CNS experienced by PwMS, impairments in the visual, vestibular, and somatosensory systems occur. These systems are all integral to postural control and degradation of the systems results in impairment of postural control [4]. The damage often presents itself in three main ways in PwMS: first, decreased ability to maintain balance; second, reduced functionality approaching the limits of stability; and third, delayed responses to postural perturbations [18, 19]. People who are more impaired due to MS (higher Expanded Disability Status Scale [EDSS] scores) and those with progressive instead of relapsing forms of MS experience impaired balance and postural control [20]. This control is fundamental for maintaining equilibrium during any activity [21]. For non-ambulatory persons, this means maintaining equilibrium of the trunk within the limits of their base of support (BoS) with respect to the surface upon which they are

seated [19, 22]. The limit of their BoS is referred to as their functional stability boundary [22, 23]. Consequently, non-ambulatory PwMS can experience reduced functional trunk mobility stemming from impaired postural control [24].

Reduced functional trunk mobility is associated with increased trunk muscle atrophy [25]. A decrease in mobility and balance correlates to a decrease in trunk muscle composition via increased degrees of fat infiltration, creating a pathophysiological relationship [24]. Muscle strength and endurance are purported to be the most probable routes by which the changes in trunk muscle composition manifest. These attributes of trunk muscles (strength and endurance) have been associated with mobility and balance in older adults [26].

1.1. Research Question in Thesis

The purpose of this thesis is to describe an exercise-based intervention program designed to improve seated postural control and test the preliminary feasibility of the intervention program. We hypothesize that core exercise will improve seated postural control over a three month period.

Chapter 2

Methods

2.1. Participants

Seventeen non-ambulatory PwMS (13 female, 4 males) were recruited through advertisements posted in the local community and through the North American Research Committee on Multiple Sclerosis research registry. Individuals were invited to participate if they met the following inclusion criteria: Diagnosis of MS, over 18 years old, main form of mobility via a wheelchair (patient determined disease steps level 7 [27]), self-reported inability to ambulate outside of the home and self-reported ability to transfer with moderate assistance or less.

2.2. Procedures

To examine the impact of a structured exercise-based intervention program, a randomized clinical trial was performed. The University of Illinois at Urbana-Champaign (UIUC) IRB approved all experimental procedures. Upon arrival for the first visit, participants were informed of the research procedures and were given the opportunity to ask questions regarding these procedures. After all questions were answered and inclusion criteria verified, participants were asked to provide informed consent.

Seventeen participants were randomly assigned using a 1:1 randomization scheme to an Intervention (IG) and a Control Group (CG). Participants were required to attend two visits that were twelve weeks apart at a research laboratory at UIUC. Due to transportation limitations, 5 participants were tested in satellite-testing locations. The same protocol, testing equipment and evaluators were used at all locations.

To examine seated postural control, a Bertec force plate was used to simultaneously measure three force components along the x, y, and z-axes and three moment components about the x, y, and z-axes for a total of six outputs (see fig. 1). The force plate was placed on a sturdy table and all participants sat unsupported on the force plate with their arms in their lap and their feet unsupported. Assessments consisted of two conditions: 1) static sitting and dynamic sitting. For the static sitting condition, participants were instructed to sit in an upright posture, as still as possible for 30 seconds, visually focusing on a static point at eye level 3 meters in front of them. For dynamic sitting condition: Participants were instructed to lean as far outwards as possible in all directions without falling and rotate about the longitudinal axis in a fluid manner, as reported in other research [22, 28]. They continued this motion for 30 seconds generating a functional stability boundary. [22]. All subjects were allowed to practice prior to completing their trials. After practice, data were collected for one static and one dynamic test during each visit.

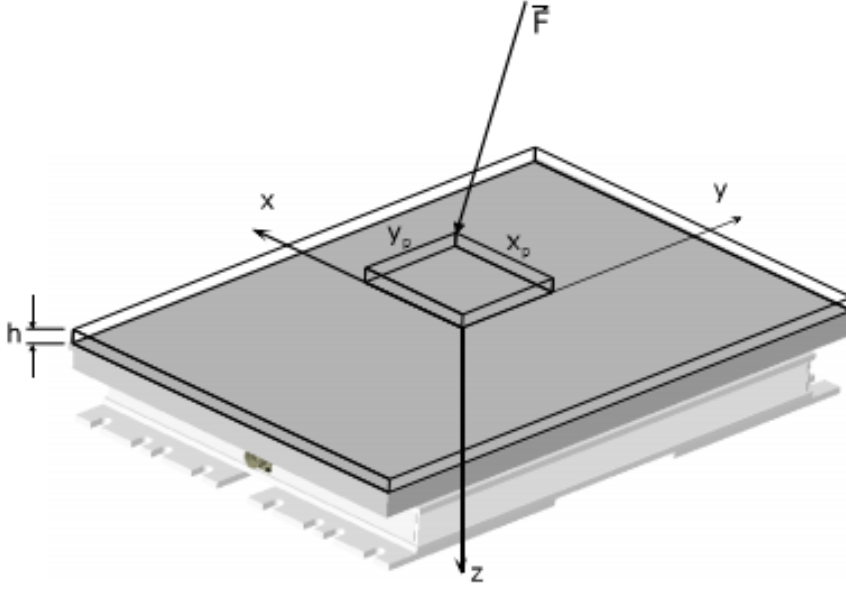


Figure 1. Diagram of force plate and axes of kinetic data collection (Bertec Corporation, Columbus, OH)

2.3. Data Reduction

Kinetic data was recorded at 1000Hz and down-sampled to 100Hz. The recording was then filtered with a fourth-order low-pass Butterworth filter with a 5Hz cutoff frequency. The virtual time to contact (VTC) and seated instability index (SII) of each participant were calculated based on the kinetic data collected. Center of pressure (CoP) was calculated along the anteroposterior and mediolateral axis by using the following equations:

$$COP_{AP} = \frac{-h \times Fx - My}{Fz} \quad (1)$$

$$COP_{ML} = \frac{-h \times Fx + My}{Fz}$$

where h is the offset between the force plate sensors and the surface.

The functional boundary was calculated using a direct least squares fitting method

[22]. VTC quantifies the temporal proximity of an individual to their functional stability boundary, which is commonly defined as the limits of the BoS in non-ambulatory persons [22, 23]. This was calculated using a position vector of the CoP on a virtual trajectory, $\tau_i(t)$, was determined for each moment in time, t_i during Static Sitting, on the basis of the instantaneous CoP velocity and acceleration:

$$x, y(\tau) = r_{xi,yi}(t_i) + v_{xi,yi}(t_i)\tau + \frac{a_{xi,yi}(t_i)\tau^2}{2} \quad (2)$$

where $r_{xi,yi}(t_i)$ is the instantaneous position vector, $v_{xi,yi}(t_i)$ is the instantaneous velocity vector, and $a_{xi,yi}(t_i)$ is the instantaneous acceleration vector in the x and y directions.

Using the current virtual trajectory, the position vector for the crossing point on the functional stability boundary from Dynamic Sitting, (x_c, y_c) , was determined by:

$$\left(\frac{x_c}{R_x}\right)^2 + \left(\frac{y_c}{R_y}\right)^2 = 1 \quad (3)$$

where R_x and R_y are the semiaxes of the ellipse traced out by the initial pivoting [22].

VTC, unlike other stabilometric variables, takes into account the dynamic relationship between CoP and BoS that allows it to adequately represent the ability of the CNS to react to perturbations that may result in falls [29]. VTC data can be depicted with various metrics but to maintain uniformity with previous literature [23, 28, 30] the mean VTC was calculated [22].

Instability is defined as being realized when the location of the ground reaction

force on the horizontal surface of support moves outside the geometric boundary [30]. SII is defined as a ratio of the CoP area from quiet sitting to the functional boundary [22], which gave a spatial understanding of the location of a participant's CoP with respect to their functional boundary.

2.4. Exercise Intervention

During the first visit, participants randomized to the IG met with a licensed Physical Therapist one-on-one after completing the baseline assessment. The Physical Therapist educated the participants on a variety of exercises designed to improve seated postural control. This included both demonstrations of the exercises and adjustments to suit the specific needs of each participant. Upon completion of the demonstration, the participants were given an opportunity to practice the exercises and receive feedback about their technique. They were then prescribed individualized regimes detailing the number of times per week and the number of repetitions per exercise that they were to complete based on their current levels of exercise. Typically they were prescribed a 3 times per week regimen at 10-15 repetitions of each exercise. A written description of the exercises (Appendix) and an individualized prescription was provided to each participant. During the study, participants were called every other week and were reminded to perform their exercises. Any questions they had about exercise techniques were also answered.

2.5. Statistical Analysis

Outcome measures were examined for normality with the Shapiro-Wilk test. If

normality was not confirmed, the data was transformed appropriately. Differences in the demographic characteristics between groups were determined by an independent samples *t*-test and independent samples Mann-Whitney U test for normal and non-normal measures respectively. VTC and SII were analyzed using a Repeated Measures ANOVA with time (pre/post) as the within subject factor and group (CG/IG) as the between subject factor. One-sample *t*-tests were used to examine the significance of percent change from zero for VTC and SII in each group (CG and IG). Significance was noted when $p < 0.05$ for both ANOVA and *t*-test analyses. Magnitude of effect size was expressed using partial eta-squared (η^2) and Cohen's guidelines of 0.02, 0.13 and 0.26 were used to classify the η^2 as small, moderate and large respectively for all ANOVA analyses [31]. Statistical analyses were completed using SPSS version 21.0 (SPSS Inc., Chicago).

Chapter 3

Results

3.1. Demographics

Demographics of the sample population were reported in Table 1. The participants' ages ranged from 27-83 years with an average age of 57.24 (11.37) years. Duration of MS ranged from 8-35 years with an average of 17.69 (8.43) and the years of wheelchair use ranged from 1-20 years with an average of 6.43 (5.14) years. None of the participants reported any injuries during the exercise program and they only required minor further instructions on the prescribed exercises.

Table 1. Participant Demographics

	MS (n=17)	Control (n=5)	Intervention (n=12)	<i>p</i> -value
	Mean (SD)	Mean (SD)	Mean (SD)	
Age (yrs)	57.24 (11.37)	58.20(5.63)	56.83(13.27)	0.506
Gender	Male= 5 Female= 12	Male= 1 Female=4	Male=4 Female=8	N/A
MS duration (yrs)	17.69(8.43)	16.40(5.13)	18.27(9.74)	0.695
Wheelchair use (yrs)	6.43(5.14)	7.50(3.00)	6.0(5.87)	0.24
VTC (sec)	1.18(0.31)	1.22(0.30)	1.17(0.32)	0.74
SII	24.53(39.93)	24.48(36.72)	24.55(42.77)	0.574
Log SII	0.98(0.57)	1.09(0.51)	0.93(0.61)	0.615

Note: *p*-value indicates group differences. Significance <0.05

3.2. VTC

When analyzing VTC, the data for both the CG and the IG were found to be normally distributed as indicated by the Shapiro-Wilk Test ($p= 0.201$ and $p= 0.704$ resp.). No significant differences were found for Time by Group interaction [$F(1,15)= 1.1$; $p= 0.31$; $\eta^2 = 0.069$]. Further analysis showed that neither Time [$F(1,15) = 2.4$; $p = 0.15$;

$\eta^2 = 0.14$] nor Group [$F(1,15) = 0.01$; $p = 0.92$; $\eta^2 = 0.001$] had significant main effects on VTC. (Figure 2)

Further analysis revealed that the CG experienced a lower percent change in VTC (0.33%) than the IG (9.64%) (Figure 3). When compared to zero (0), the IG displayed significant improvements ($p = 0.007$). Changes were not found to be significant among the CG ($p = 0.97$).

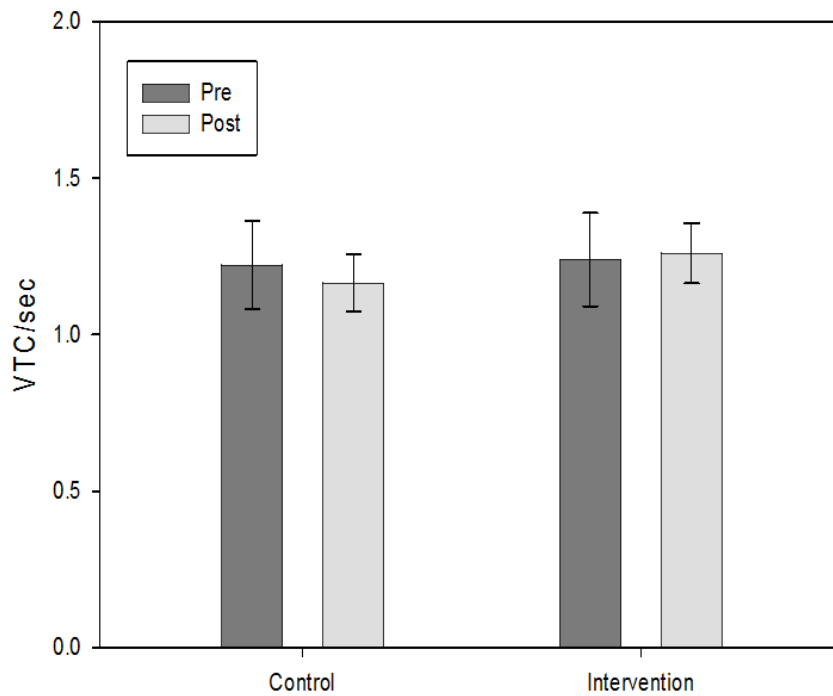


Figure 2. Virtual Time to Contact (VTC) as a function of Time and Group

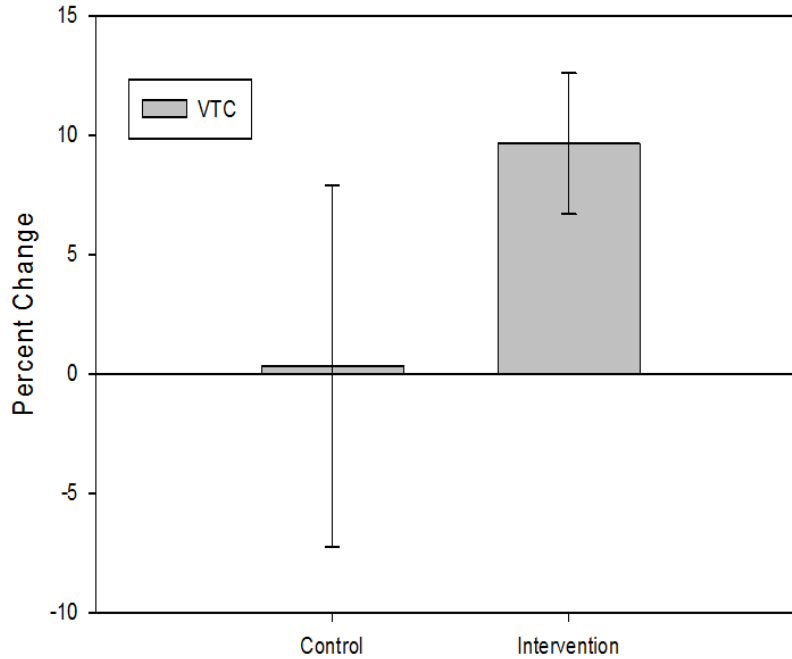


Figure 3. Percent change of Virtual Time to Contact (VTC)

3.3. SII

When analyzing SII, the data for both the CG and the IG were found to be non-normal using the Shapiro-Wilk Test ($p= 0.02$ and $p= 0.00$ resp.). As such, logarithmically transformed values were generated for SII the CG ($p=0.12$) and IG ($p= 0.115$) and compared pre-intervention values to post-intervention values. No significant differences were found for Time by Group interaction [$F(1,15) = 2.28$; $p= 0.15$; $\eta^2 = 0.13$]. There was a moderate effect of the Time by Group interaction on SII, as shown by $\eta^2 = 0.13$. Upon further analysis, no significant differences were found among Time [$F(1,15) = 0.44$; $p= 0.84$; $\eta^2 = 0.003$] or Group [$F(1,15) = 0.919$; $p= 0.35$; $\eta^2 = 0.058$]. (Figure 4)

The CG experienced a lower percent change in SII (-8.46%) than the IG (61.95%). Statistical analysis showed that neither the CG ($p= 0.33$) nor the IG ($p= 0.671$) experienced a significant change compared to 0. (Figure 5)

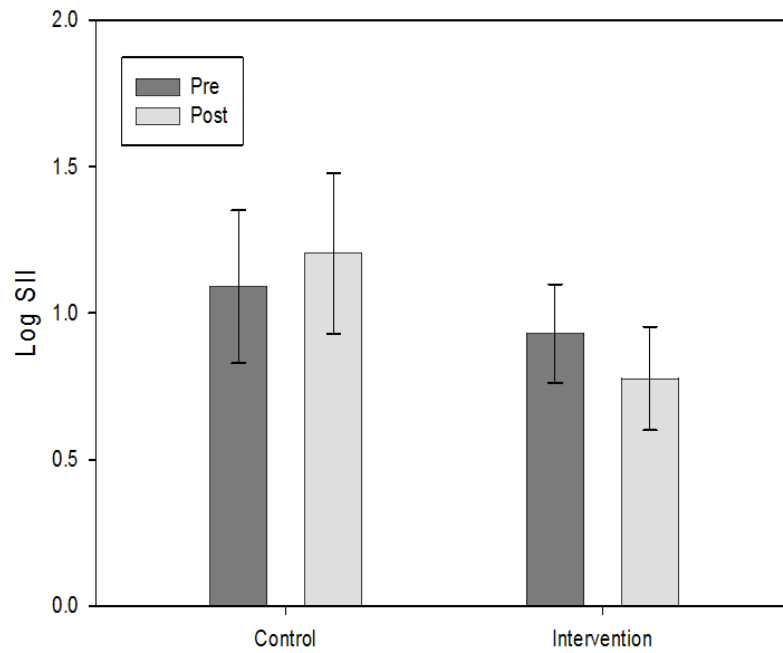


Figure 4. Logarithmically transformed Seated Instability Index (Log SII) as a function of Time and Group

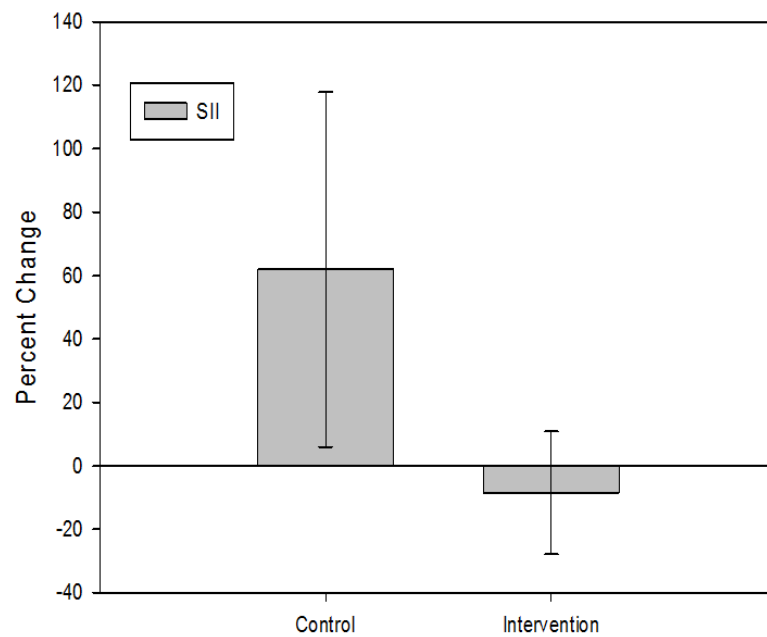


Figure 5. Percent change of Seated Instability Index (SII)

Chapter 4

Discussion

The purpose of this investigation was to examine the effect of an exercise-based intervention on seated postural control in non-ambulatory PwMS. Results indicate that percent change in VTC improved significantly after exposure to the intervention. In addition, a moderate SII effect size was found, although results were not significant. No significant differences were found among VTC or SII between study groups after the IG received the intervention. The observations made in this study may lend some insight into a little known field. While core exercise, and exercise in general, has been previously established as a safe, non-pharmacological treatment alternative for ambulatory PwMS [32, 33] this has not yet been examined among non-ambulatory PwMS. The changes observed as a result of the intervention are similar to research performed in other populations.

A review done by Motl et al. [34] found that exercise training has beneficial effects on muscular strength, aerobic capacity and ambulatory performance in ambulatory PwMS. This review also found beneficial neurological effects with no clear evidence of detrimental effects of any kind due to the exercise training. Recent research by Kasser et al. [35] and Sosnoff et al. [36] have corroborated these findings. Kasser et al. [35] found that exercise can result in improved balance in the ambulatory MS population whilst Sosnoff et al. found that home-based exercise programs reduced fall risk in older ambulatory adults with MS.

Looking at other impaired populations exercise has consistently yielded positive results in balance improvement. In persons who have sustained a stroke, research has

been done observing the effect of core exercise on trunk impairment. Yu, et al. [37] found that core exercise improved core stability by improving muscle activity. This was displayed via increased surface electromyography as well as improved trunk impairment scale (TIS) scores as a result of exercise. In the field of Spinal Cord Injury (SCI) there has been some research done looking at the relationship between exercise and balance control [38, 39]. There is evidence of the effectiveness of exercise as a method of treatment in both ambulatory and non-ambulatory persons with SCI as seen in a review done by Harvey and colleagues [39]. Aluko and colleagues [40] found relationships between core exercises and improvements in stability in persons with low back pain.

Similar to the aforementioned research, the results of our study showed that after exposure to the intervention, improvements in seated postural control occurred. Although there were no significant differences between groups in our study, a significant percent change from zero of VTC was observed after IG participants were exposed to the intervention. This is encouraging and suggests that the intervention had a positive effect on seated postural control. With improvements in study design, significant results are possible.

The novelty of this study is that it is one of the first to examine a relationship between seated postural control and exercise interventions in non-ambulatory PwMS [7]. Despite the fact that non-ambulatory PwMS experience substantial balance and mobility limitations, there is a lack of studies available to guide clinicians on evidence based treatment protocols [41]. This makes pinpointing a target area for rehabilitation much more difficult. By focusing on core exercise, this study attempts to establish a relationship between changes in seated postural control in non-ambulatory PwMS and lay

groundwork for evidenced based treatment strategies in the future.

The benefits of the intervention have the potential to go beyond improvement in seated postural control. Seated postural control plays a big role in maintaining balance. Since balance is a key facet in completing a variety of tasks associated with daily living for non-ambulatory PwMS [42], the benefits of the intervention can extend to these tasks as well. These tasks often include operating wheeled mobility devices, and transferring to perform activities of daily living [4].

Due to the neurodegenerative effects of MS, these aforementioned activities also have high risk of falling [4, 42]. Falls and the injuries associated with falling are amongst the biggest risk factors affecting QoL in non-ambulatory PwMS [4] but the physical implications are not the only risk factors associated with falls [6]. Non-ambulatory PwMS can develop a debilitating fear of falling, which can manifest itself in a variety of ways including loss of confidence, loss of independence, physiological deconditioning, and difficulty performing societal roles and necessary activities of daily living [13, 43].

Due to the self-imposed limitations on physical activity and community integration, a disuse-disability cycle resulting in increased risk for falls may be implied. By consciously limiting themselves from physical activity, persons are unconsciously increasing the effects of their disability [43]. It is possible that a combination of the effects of a person's MS and the disuse-disability cycle could negatively impact their postural control. Modifying the amount of physical activity in non-ambulatory PwMS has the potential to reduce the impact of a fear of falling and break the disuse-disability cycle.

4.1. Limitations and Future Directions

There are many limitations associated with this study to consider. First, the

sample size of the study was small ($n=17$). Thus, the study's results may not be generalizable to the overall non-ambulatory PwMS population. A small sample size also resulted in large error values and greatly reduced the chances of statistical significance for any variable. An uneven distribution of the sample between groups (CG= 5, IG= 12) further affected chances of statistical significance.

The duration of the study was a limitation. Three months may not be the optimal time frame for maximal effect of the intervention. It is possible that the intervention could have a stronger effect if applied over a longer period of time. The timeframe of this study however was consistent with many of the other studies reviewed by Rice et al. and Motl et al. [7, 34].

In addition, data was only collected immediately post intervention. This limited our ability to observe the long-term effects of our intervention. Having a third assessment point three months after the completion of the intervention would give us an opportunity to assess the longevity of our intervention effect.

Another limitation is that we were unable to directly observe the participants throughout the intervention. The participants completed the exercise sessions at home after learning proper technique on their first visit and were monitored via periodic phone check-ins. Even so, more direct observation would have ensured the participants were completing each exercise properly and completely.

Finally, it was difficult to ascertain which factor of seated postural control was improved by the intervention. Core exercise has the potential to improve multiple facets of balance and postural control, including muscle endurance [24, 26]. Unfortunately, force platform metrics give an overall measure of seated postural control and no

information on specific factors, which prevents the study from examining specific components of balance.

Future research is imperative if we are to better understand the factors contributing to seated postural control in non-ambulatory PwMS. One way to do this is by including additional participants. Increasing the number of participants overall would increase the strength of the statistical analyses and better validate the sample's generalizability to the overall non-ambulatory MS population.

We are also interested in examining the impact of group exercise programs. Weekly group exercise programs have been shown to result in fall reduction and improved physical function in a variety of populations including MS [33, 44-46]. Group exercises have the added benefit of providing participants with moral support and encouragement to complete the activities required of them.

Finally, we are interested in further examining seated postural control. Improving the elements that compose the protocols used for measuring seated postural control can give supplementary insight into the factors affecting it. Tests of muscle strength and endurance would give finite evidence as to whether a change in musculature is a factor in the changes found due to the intervention [26]. Adding such tests to the assessment protocol would help to produce more robust results and improve the interpretation of said results.

4.2. Conclusion

This research focused on examining the feasibility of exercise as a tool to improve seated postural control among non-ambulatory PwMS. The study demonstrated that after

exposure to the exercise intervention, a significant difference in percent change of VTC of non-ambulatory PwMS occurred. However, no significant differences were seen between participants who were exposed to the intervention and those who were not. The exercise intervention may be a valid means of improving seated postural control in non-ambulatory PwMS, however further investigation is needed. Results from this study can be used as a basis for further future research and design of evidenced based clinical programs to improve seated postural control among non-ambulatory PwMS.

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Appendix A: Exercise Instruction Manual

Management of Fall Risk in Non-Community Ambulators Affected by Multiple Sclerosis

Below is a list of exercises designed to improve the strength of your core (torso) muscles and help to improve your balance in a sitting position.

All of these exercises are performed in a sitting position. Please sit on a firm, stable surface and place your hands on either side of your legs. You can use your hands to assist with balance to start with but as you get stronger, try to put your hands in your lap during the exercises. Ideally, your back should not be supported.

You should have a friend or family member stand next to you to assure that you don't fall during the exercises.

Please start doing each exercise _____ times, _____ time(s) per day, _____ days per week.

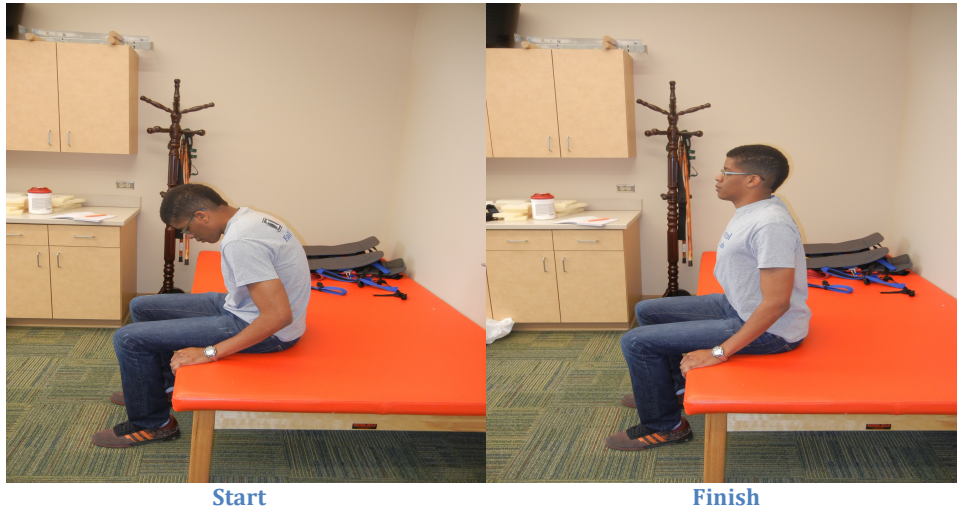
After you exercise you should feel soreness in the muscles but not pain or extreme fatigue. Listen to your body! If you are feeling extreme fatigue, decrease the number of repetitions and/or reduce the number of days per week that you exercise. If you do not feel that the exercises are difficult, increase the number of repetitions performed (increase by 5 repetitions each week) or the number of times you exercise each day (max = 3 times per day).

If you have questions, please feel free to call Dr. Rice at 217-333-4650.

Make sure you always have someone with you while you are performing your exercises to assure safety!!!

Warm-Up: Before you start your exercise routine, be sure to perform a short warm-up to get your muscles ready to go.

Round and Arch Spine: Start by rounding your shoulders forward and then arch your back. Each time you arch your back counts as 1 repetition. Start with a small movement first and then try to go through a greater range of motion as your muscles warm up.



Torso Rotations: Gently twist your trunk first to the right, then the left. Each time you turn to the left counts as 1 repetition. Please note: if you have had a back surgery, check with your doctor about the safety of this exercise.



Routine:

Pelvic Tilt: Start out in neutral sitting position. Tilt your pelvis forward and then squeeze your abdominal muscles to pull your pelvis back. Each time you squeeze your abdominal muscles and pull backwards counts as 1 repetition.



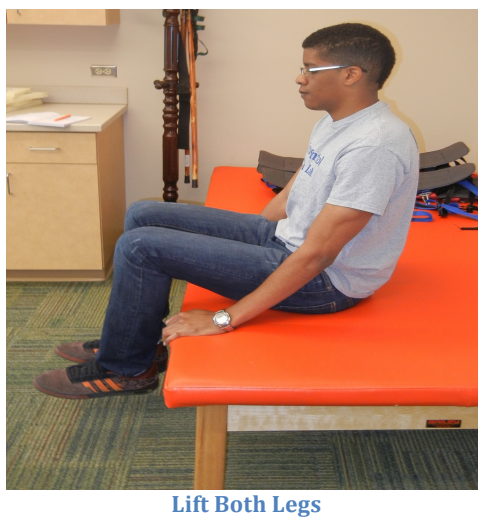
Marching: Lift your right foot off of the ground, as high as possible and then return your foot to the ground. Lift your left foot up, as high as possible, and return it to the ground. Each time you lift your left leg counts as 1 repetition.



Challenge: Twist your elbow to your opposite knee while marching.



Challenge 2: Try to lift both feet off the ground at the same time.



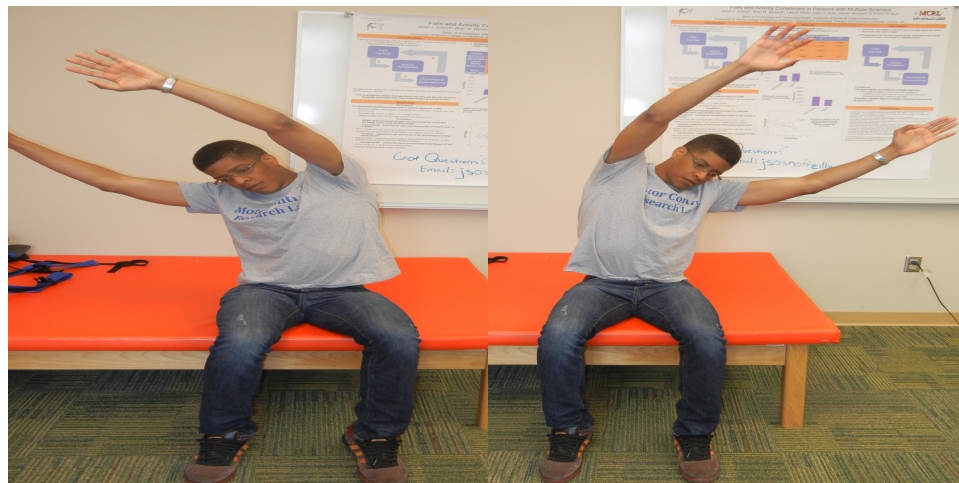
Lateral Spinal Flexion: While sitting, bend your body to the right side, then the left. Each time you bend to the left counts as 1 repetition.



Start

Finish

Challenge: Lift your arms over your head!



Start

Finish

Seated Torso Twist: Reach behind your back to your right and then your left. Each time you turn toward the left counts as 1 repetition. If you have had a back surgery, consult with your physician prior to performing this exercise.



Start

Finish

Lean Backs: Lean your body as far back as possible and return to an upright sitting position.



Lean Backs

Scapular Retraction: Bend your elbows to 90 degrees; lift your arms approximately 6 inches away from the side of your body. Squeeze your shoulder blades together and hold for approximately 5 seconds each time.



Scapular Retraction

Forward/Lateral Reach: Reach forward, to the right and to the left. Each time you reach forward counts as 1 repetition.



Reach Forward

Reach (Right) and Left

Challenge: Don't hold onto the surface you are sitting on.

Scoot: Scoot your bottom to the right 2 inches, backwards 2 inches, to the left 2 inches and forward 2 inches. (By the end, you will be back in the same position) Each time you scoot forward counts as 1 repetition.



Scoot Right



Scoot Backward



Scoot Left



Scoot Forward

Touch Your Toes: Bend over and touch your toes (or as close to your toes as possible).



Touch Your Toes

Cool Down: Finish up your exercise routine with a few stretches. This will help you to recover faster.

Rotational Twists: Gently twist to the right and hold for 5 seconds, twist to the left and hold for 5 seconds. Each time you twist to the left counts as 1 repetition.



Start



Finish

Side Stretch: Gently lean to your right side and hold for 5 seconds. Repeat on left.



You are done!!